Space Command, Military Operations in Space

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Introduction

It was recently decided to create an arm of the Military to cover space operations. This is called Space Command.

In 1946, the National Advisory Committee for Aeronautics (NACA) had been in charge of Civilian aviation, as well as several rocket-plane projects. They were involved in the early efforts to launch a satellite for the International Geophysical Year (actually 18 months). The launch of the Soviet satellite first was seen as a threat in several areas – national security and perceived technology world leadership. President Eisenhower directed NACA to form a special committee on space technology. A new civilian space agency would be formed to oversee and direct all non-military space activities. In 1958, the president signed the National Aeronautics and Space Act, creating the NASA agency. The core and starting point was NACA.

All of the information in this book came from open sources. As far as I know, no aliens were harmed in the production of this book.

Author

The author received a Bachelors degree in Electrical Engineering from Carnegie-Mellon University, and Masters Degrees in Physics and Computer Science from the Johns Hopkins University.

He was glued to the black & white TV for the launch of the Vanguard, the U. S.'s first satellite, through the Apollo missions.

He began his career in Aerospace with Fairchild Industries on the ATS-6 (Applications Technology Satellite-6), program, a communication satellite that developed much of the technology for the TDRSS (Tracking and Data Relay Satellite System). At Fairchild, Mr. Stakem made the amazing discovery that computers were put onboard the spacecraft. He quickly made himself the expert on their support. He followed the ATS-6 Program through its operation phase, and worked on other projects at NASA’s Goddard Space Flight

Center including the Hubble Space Telescope, the International Ultraviolet Explorer (IUE), the Solar Maximum Mission (SMM), some of the Landsat missions, and others. He was posted to NASA's Jet Propulsion Laboratory for the MARS-Jupiter-Saturn (MJS-77), which later became the Voyager mission. It is still operating and returning data from outside the solar system at this writing.

The author has been at almost all of the facilities and launch sites discussed, in an official capacity. There is always time to slip away and visit the museums.

Mr. Stakem is affiliated with the Whiting School of Engineering of the Johns Hopkins University. He received NASA's Space Shuttle Program Managers commendation award, as well as two NASA Group Achievement awards, the NASA Apollo-Soyuz Test Program Award, and a Certificate of Appreciation, NASA Earth Science Technology Office. Mr. Stakem has completed over 42 NASA Certification Courses in various areas

Military in Space

Even before the first satellite was launched, various branches of the military were involved in launch vehicles. The Army had the German von Braun team and a lot of captured V-2 missiles. A working center was set up at the Redstone Arsenal in Alabama. Test launches were conducted at White Sands in New Mexico.

V-2

Although the Americans, the Russians, and the Germans were experimenting with rockets from the 1920's, the German efforts, spurred on by World War-2 stand out. The V-1, what we would now call a cruise missile, was guided by a simple distance-measuring device driven by a small propeller. It required pre-calculations, what the artillery people call firing tables. You launch from a known position in a known direction. When the distance counter triggered, the missile was put into a steep dive onto the target. But the missiles

flew low and slow, and many were shot down (some by the Author's father), or were simply flipped out of control by fighter planes. They were not, by any means, an accurate weapon.

The V-2 was a true ballistic missile, developed by the Von Braun team at Peenemunde. Not only did they develop the world's first operational ballistic missile during wartime, but they managed to turn it over to the Army for use in the field. Quite a few were fired against England and the Port of Antwerp with devastating effect. There was no practical defense.

No real internal guidance mechanism was used. The missiles were launched from a pre-surveyed location in a precise direction. A known distance to the target determined the engine burn time, which was set into the vehicle before launch. After that, no changes were possible. It was inaccurate, but devastating when it worked.

The German V-2 Field Operations Manual was captured by US forces along with missiles and launch and ground support equipment. The manual was translated at the Army's Aberdeen Proving Grounds (MD). It tells the ground troops how to launch the missile. The manual assumes a high school education. After the launch site is accurately surveyed, the missile was erected and fueled. Then, the troops were instructed to "…point fin number one towards London…" The distance was set into the timer that would shut down the engine, the missile was launched, and the support equipment made a hasty withdrawal to avoid Allied air power. This approach was hardly changed as late as the First Iraq War. Captured V-2's were used in the European Project Hermes, but a need was seen to produce vehicles based on the V-2, as the supply of captured rockets was going to run out. Also, the V-2's were never meant for research, and tumbled at high altitude, They were designed as weapons, and carried a rather large payload, one ton. This was way in excess of the science payloads, leading to the launch of a lot of lead ballast.

Viking Launch Vehicle

The Viking was designed to replace the V-2's as a science payload

carrier. It was half the size, in terms of mass, and power. Both used active guidance, and the same fuel and oxidizer (alcohol and lox). The Viking used the Reaction Motors XLR10-RM-2, producing in excess of 20,000 lbf of thrust. It improved on the V-2 design, by removing the graphic vanes in the exhaust for steering, and using a gimballed nozzle. Control in the roll axis was by turbo-pump exhaust through jets on the fins. An aluminum skin in place of steel was used, and the tanks were a structural element. The Viking was a bit longer, but more slender. It had a better mass ratio, the ratio of fueled to empty weight. Vikings were launched from the deck of the USS Norton Sound at sea. By 1951, the Viking beat the standing V-2 altitude record by traveling to 136 miles. A total of twelve vehicles were launched 1949-1955.

Vanguard Launch Vehicle

The Vanguard rocket was a Navy Program to place satellite in orbit. Project Vanguard ran from 1957 to 1959, but the Soviets were the first to orbit. There were eleven attempted launches, with three successful satellites in orbit. At the time, although it had never been done, there were three U. S. candidate rockets for putting a satellite in orbit. These were the Air Force's Atlas, the Army Ballistic Missile Agency Redstone, and the Navy variant of the Viking. Redstone, a three stage vehicle, had a capacity to orbit of 9 kilograms. The vehicle had no fins, but used gimballed engines on the first and second stages, and the third stage was spin-stabilized. Note also that second stage engine nozzles (“bells”) are wider than first stage ones. This is because they operate higher up, where the atmosphere is thinner. This allows for a better and quicker expansion of the exhaust gas.

I had a friend who joined the Navy Vanguard Team. Some work was being done at the Naval Research Lab in Washington, D.C. They wanted a somewhat remote, dedicated location for Vanguard, so a chunk of the National Agricultural Research Center in Greenbelt, Maryland was appropriated. My friend had orders to report there. When he arrived, there was a single

trailer in a corn field.

Now, the Goddard Space Flight Center is the hub of the NASA world wide communications Network, and the Lead Center for unmanned spaceflight. It was dedicated in 1959 by rocket pioneer Dr. Robert Goddard's widow. Goddard is the lead NASA center for unmanned spacecraft. It has worked on hundreds of spacecraft projects, including the Hubble Space Telescope, and the upcoming James Web Space Telescope.

The first stage used a General Electric X-405 liquid fuel engine (LOX and kerosene) with more than 30,000 lbf of thrust. The second stage used an Aerojet General AJ10-37, 7600 lbf of thrust, and using nitric acid and UDMH. The third stage used solid fuel, and was supplied by the Allegany Ballistics Laboratory. It had 2,600 lbf of thrust.

The first real Vanguard launched with inert upper stages. By then, the Soviet satellite was in orbit. There was a chance the next test flight could have put a U.S. Satellite in orbit, but it only reached an altitude of 1.2 meters, before it exploded. The satellite was still transmitting from nearby bushes. The fourth try was the winner, and the satellite and its third stage remain in orbit to this day, the oldest man-made artifacts in space. It's a high orbit, so they should remain recoverable for hundreds of years. Let's crowd-source a project to bring them back to the Smithsonian. Two more Vanguard satellites were placed in orbit before the end of the program. In total, Vanguard had a dozen successful launches, from 1957 to 1959.

Ballistic Missiles

Ballistic missiles, originally designed to deliver nuclear warheads, were re-purposed to Civilian programs, run by NASA. These included the Atlas and the Titan. Later, NASA developed their own line of launch vehicles, with different goals such as the moon in mind. These included the Saturn series, and the Space Shuttle. Now, launch vehicles are seen more as a service, with commercial vendors available.

MOL

The Air Force's planned Manned Orbital Laboratory, circa 1963, took advantage of NASA's two person capsule, the Gemini. It was designed by Douglas Aircraft, but never flew. It was a successor to the Boeing X-20, which was also canceled.

The MOL was designed for 40 day missions in space with a crew of 2. It had a hatch in the heat-shield, so astronauts could enter the lab, already deployed in orbit. The station would not use a pure oxygen atmosphere, but rather a mix with helium. The launch vehicle was to be a Titan. The habitable volume of the lab was 400 cubic feet. There had been 3 groups of Astronauts assigned to the MOL Project. There were to be missions from 1970 through 1975, giving 7 visits to the station. There was one unmanned launch of a MOL mock-up and a Gemini capsule, refurbished after its Gemini-2 flight. The capsule was recovered.

As opposed to the NASA manned flights, and the Space Station, the MOL was designed to operate in a polar orbit.

The MOL Project was canceled in 1969, without a flight. The Soviets had a similar project called Almaz, in the 1970's. These were military versions of the Salyut.

Almaz (“Diamond”) was a Soviet Military Reconnaissance station, identified as Salyut 2, 3, and 5. The program ran from 1973-1976. These Soyuz craft, were referred to as Orbital Pilot Stations (OPS). This program was similar to the USAF's MOL Project. The Almaz carried a 23mm automatic cannon, for self-defense. It was tested in orbit against a satellite target.

The MOL program was canceled in 1977. Half of the MOL astronauts transferred to NASA as Astronaut Group 7.

Rocket Planes

This section discusses various rocket plane projects, initially by the Military.

German WW-II efforts

This section discusses Germany's World War Two operations with ballistic missiles and rocket planes.

Silbervogel

Eugen Sanger, a doctoral candidate at Vienna Polytech in 1933, proposed a Mach-10, 160 km altitude capable glider. He published his *Techniques of Rocket Flight* in 1933. He refined his project to a hypersonic boost-glide vehicle in 1934. It was designed to achieve Mach 13 at engine cut-off. It was then capable of a 5,000 km glide at Mach 3.3 and 50 km. This is when every other plane was using one or more propellers.

He produced a paper later in World War-II, entitled *Concerning Rocket Propulsion for Long-Range Bombers.* This described a 28 meter long spaceplane with a 15m wingspan. The top speed was to be 21,800 kph, and a range of 23,400 km. It was to be launched by a rocket powered sled, using liquid oxygen and alcohol. The plane's rocket motor used liquid oxygen and kerosene.

Sanger sent a proposal to the German Ministry of Aviation in 1941, who promptly filed it. He went on to design and work on a ramjet interceptor/fighter plane, the Skoda-Kauba Sk P 14.01. This was to be powered by an engine he designed. The craft was to have been launched by booster rockets to a speed where the ram jet would operate. The top speed was calculated to be 1000 km/h. The first model was to have a wingspan of 7 meters, and a length of nearly 10. This plane was developed in 1945 to address the mass bombings of Germany during the war, but it never made it to service. The Germans were trying to find a way to counter the Allies' thousand plane raids. Late in the war, the British and Americans could field that many planes, daily, day and night.

The *Silbervogel* (German: Silver Bird) featured a lifting body architecture, where the entire lower surface of the craft acted as a wing. It was sub-orbital, and achieved long distances by skipping

along the upper atmosphere. He also introduced the concept, in use today, of cooling the rocket nozzle and pressurizing the fuel, by circulating it around the nozzle in tubes.

The project was adopted by the Luftwaffe as the *Amerika Bomber*. It would launch from Germany, bomb New York, and fly to Japan for recovery. The scary part is, had Germany succeeded in constructing it, and in constructing an atomic bomb, history would have been very different. After the war, Dr. Walter Dornberger, the military officer in control of the V-1, V-2, and similar rocket projects came to the United States to work with the von Braun team at the Redstone arsenal in Huntsville, Alabama. He carefully referred to the Silbervogel as the *Antipodal Bomber*. The Russians worked on a rocket-powered sub-orbital bomber influenced heavily by Sanger's design, in the late 1940's – 1950. Luckily, Sanger had made an error in a heat flow calculation, that would have resulted in the craft being destroyed upon reentry. The early work by Sanger in Germany was applied to many of the subsequent German rocket projects.

Principles of the Silbervogel also influenced the U. S. rocket planes such as the X-15 and the X-20. Sanger continued work on key aerospace concepts in Germany, designing a ramjet powered spaceplane in the 1960's. He also did work in laser propulsion and solar sailing. In 1985, Messerschmitt-Bolkow-Blohm used the Sanger concept in a study of a horizontally launched, two-stage-to-orbit plane.

Sanger can certainly be called the Father of the Space Plane, as he had worked out most the the details by 1933.

World-War-II Rocket powered fighters

Rocket powered aircraft were flying in Germany in the 1930's, thanks to some good theoretical work, good engineering, and a loophole in the Armistice for World War-I. Germany was banned from developing any powered aircraft, which meant, at the time, anything with a propeller. To keep a cadre of pilots available, the sport of

gliding became popular. They couldn't tow them to altitude with a plane, so they launched them downhill, or with a long tether that was wound in quickly. A rocket engine in a glider would enable the craft to get to altitude on its own. It bent the rules, but just a bit.

Max Valier was working with car manufacturer Opel to get a rocket powered car going, as a publicity stunt for the car company. They started out using solid fueled rockets in 1928. First tests were disappointing, but they finally got to 125 mph. On railroad tracks, another model got to 180 mph, and used retro rockets to brake. Valier became a proponent of liquid fuel, and influenced a budding rocket pioneer, Wernher von Braun. Valier was killed when a rocket motor explosion drove a sharp splinter through his heart. Opel's company dropped the rocket car experiments.

The Heinkel 112 was the first aircraft to fly with a rocket engine, using von Braun's design. This was in the summer of 1937. It used liquid oxygen and alcohol, the same fuel that von Braun would use in his V-2 rocket some years later. The Heinkel P.1977 was a interceptor developed under the German Emergency Fighter Program, a response to heavy day and night bombing by the British and Americans.

Helmut Walter was also experimenting with liquid rocket engines. He used the more dangerous methanol/water/hydrazine fuel with hydrogen peroxide. One of his engines was tested in a Heinkel-111 aircraft as a take-off enhancement. Later, a HE-176 was towed behind a turbocharged 7.6 liter Mercedes car for take off, then it lit off the liquid engine. Evidently, the Allies from World War-I were not aware of this work, or didn't consider it important. The HE-176 was the first aircraft to fly with a liquid rocket engine. The earlier Espenlaub E-7 and Opel-Sander Rak-1 used solid fuel engines. Design of the HE-176 was begun in 1936. It used the Walter HWK-R1 engine. It was 6.2 meters in length, with a wing span of 5 meters. Three units were fitted with a von Braun liquid oxygen/alcohol engine. It flew in 1937. Work was officially stopped on the project in late 1939.

The German rocket planes were not going to space, but were designed as bombers and fighters that would be much faster than any of their propeller-driven adversaries. These efforts resulted in operational rocket planes, too little, too late. They did heavily influence later rocket craft, particularly in the United States. Operationally, against bomber squadrons with fighter escort, the plane's were of limited effectiveness, due to the short burn time of the engine. After the fuel was used up, the planes dove for the ground at high speed, and glided to a landing. This was noticed by the fighter-escorts, who managed to follow them down and blow them out of the sky as they prepared for landing.

Generally, the planes could not take off unassisted, so they were towed or carried by a larger plane. They could glide to a landing, after their mission was complete, or the fuel ran out..

The Heinkel HE-176 first flew in 1939, as the world's first rocket aircraft. Unfortunately, all of the documentation for the project were destroyed during the war, and only two pictures survive. There were actually deployed against Allied bomber formations late in the war, but proved almost as dangerous to the pilots as to their prey. Engine malfunctions and the dangerous nature of the fuel and oxidizer were a threat to the pilots and ground crew.

Warsitz, in his book about his father, Erich Warsitz, the test pilot of rocket aircraft for the Luftwaffe, has his father mention that there were using data from a 1937 U.S. NACA Report, “Tests of 16 Related Airfoils at High Speeds.”

The DFS-194 was a tailless design, originally with a pusher propeller. It was transitioned to a rocket plane, with first flight in 1940. It used a Walter R I-203 liquid fuel engine. It managed 340 mph on its first flight. It led to the Messerschmitt Me-163. That was the first aircraft to achieve 1,000 km/hr in level flight, not quite to the sound barrier. It was also the first mass-produced rocket plane.

The HE-162 Volksjager was a result of Germany's Emergency

Fighter Program, built by Heinkel. It was constructed of wood. The ME-262A and the AR 234B were already in service, utilizing scarce strategic materials, and available rocket engines. It was introduced too late to make any impact on World War-II. It was originally powered by a turbojet engine, but a BMW 718 liquid fueled rocket engine was added, for speed bursts in combat. The fuel was diesel, and the oxidizer was red fuming nitric acid (one of the author's all-time favorites).

The ME-163 *Komet* was the first operational rocket-powered fighter aircraft. It was a tail-less design, dated back to 1929. It was also the first aircraft to exceed 1,000 km/hr, not quite the speed of sound. This record was kept secret. It was not pushed any faster, as the aerodynamics of the trans-sonic region was not well understood, and the necessarily wind tunnels for testing were not available. This speed record was not surpassed until late 1947, when an American jet went faster. In July 1944, a German pilot achieved 1,130 km/hr. This was vastly faster than the Allies' bomber fleet, and escort fighters. Over 300 of the planes were built, starting in 1941. Slave labor in concentration camps was used for their construction. The follow-on ME-163b was tested at the rocket range at Peenemunde. It was armored, and had 200 gallons of T-stoff, and 110 gallons of C-stoff in the wings. That gave 4-5 minutes of powered flight, after which the plane became a glider. There was no tail, but the craft used elevon control. Famed Aviatrix Hanna Reitsch flew the craft, but crashed it. The original plane was equipped with 20mm cannon, upgraded to 30 mm in the B model, with 60 rounds of ammunition.

The original engine was from Walter, the R-1-203, using a mono-propellant,stabilized high-test hydrogen peroxide (above 85%). This fuel is extremely dangerous and unstable, and almost anything else acts as a catalyst. This engine was used operationally, but the propulsion unit was more of a danger to the pilot, than the plane was to the bomber fleets. Later, the engine was switched to a bi-propellant using hydrazine and alcohol, with the oxygen from the decomposition of the hydrogen peroxide. This may have been more dangerous than the previous. The two liquids were hypergolic,

meaning they reacted violently when mixed. No ignition source was needed. Ground handling of the liquids was possibly more dangerous than flying the plane. The pilots did not have pressure suits, which limited the ceiling of the aircraft. They did have an oxygen mask. In one terrible accident, the oxidizer, which reacts with organic matter, leaked into the cockpit at landing, and dissolved the pilot.

The plane had wooden wings, no tail, and only elevon control. The onboard tanks gave about 4-5 minutes of powered flight, and it landed as a glider. The engine developed around 3,750 pounds of thrust. The plane had set a world speed record of 572 miles per hour at the Peenemunde test facility, but this information was kept secret until after the war. In 1941, it reached 623 mph, Mach .84. Not much was known about aerodynamics beyond that point, as that exceeded the capability of contemporary wind tunnels. They suspected but did not know there was a "sound barrier." This is simply a change in the aerodynamics. Some aircraft controls are reversed in their effects. Drag and vibration increase abruptly. These effects are now well understood, and addressed by design.

The captured ME-163, circa 1941, influenced post-war aircraft research by NACA (predecessor to NASA). The designs of the F102A, the F106A, and the B-58 aircraft were directly influenced, as was the experimental X-1 and X-15.

The DFS-228 was a rocket-powered reconnaissance aircraft. By the end of World War-II, only two un-powered prototypes had been flown. It was essentially, a sailplane that could launch itself to high altitudes. It became a project of the German Aviation Ministry. It was to use the Walter HWK 109-509 engine, the same as used in the ME-163 and the Ba349. The prototype was captured by U.S. Troops in 1946, and was sent to the U.K. The Walter engine used C-Stoff and T-Stoff, which are hypergolic. The ratio was 3 parts T to 1 part C. The engine produced about 17 kilo-newtons of thrust (3,800 lf-f). A turbo-pump scheme was used to get fuel and oxidizer into the engine. This was the approach used in the V-2 rockets, and most launch vehicles to this day. An improved engine had a burn time of 12

minutes. These rocket engines can be seen at the National Museum of the United States Air Force at Wright-Patterson AFB, Dayton, Ohio.

The TEW16/43-13 was a rocket fighter from German aeronautical company Arado, a low wing interceptor. It used the Walter HWK 509A engine, burning T-Stoff and C-Stoff. It carried automatic cannon in the nose. It was 9.7 meters long, with a wing span of 8.5 meters. Also from Arado was the E.381, “smallest fighter,” not designed for pilot comfort. It was designed to be taken to altitude by the Ar234, an operational jet bomber. One of the bombers can be seen at the Smithsonian's Udvar-Hazy Center at Dulles Airport, Virginia. The smaller craft had a short powered flight and a long glide. The pilot flew prone to provide the plane with a low profile.

The Junkers EF-126 was supposed to be powered by a pulse jet engine, like the V-1 “cruise missile.” It was converted to the rocket-powered EF-127. These were not produced by the end of World War-2.

The So344 was a strange and desperate design. The nose was a 400 kilogram explosive device, which was detachable, and had a proximity fuse. The plane was flown to altitude on another plane, and released to use its Walter HWK 109-509 rocket engine to enhance its speed. The pilot would release the payload into a formation of bombers, and then land. There was some question of pilot survive-ability. Only a scaled -down prototype was built.

Even Zeppelin wanted to be in the rocket plane business. They proposed the Fliegende Panzerfaust (Flying Armored Fist). It would be towed above the altitude of a bomber formation by a fighter plane, and released. It would then ignite its six solid fuel engines. After its mission, due to the rockets burning out, the center of gravity shifted to a bad location. The plane was to be designed to break in half, with each half parachuting to the ground. This one did not get off the drafting board, or the ground.

The ME-262 was developed as an improvement to the -163, but only

three prototypes were produced by the end of the war, and none flew under their own power. The JU-248 rocket plane was designed by Junkers. The Americans captured the plant in April of 1945, and secured the prototypes. One went to the U.S., and one to Russia. The Russians used it as a basis for their MiG-270 rocket power interceptor. This had a maximum speed of 581 mph, and could travel to more than 55,000 feet.

Another simpler rocket plane design was used in combat by the Germans. This was the BA-349 *Natter*. It used a liquid fueled Walter engine, and was launched vertically. After the mission, the rocket engine and the pilot parachuted to the ground, and the rest of the plane crashed. It was built to be expendable; only the engine and the pilot were important. The plane made its first manned flight in March, 1945, and killed the pilot.

The German V-1 was what we now call a cruise missile, and was operated unmanned. It used a pulse jet engine, which differs from both a jet engine and a rocket engine. A rocket engine carries its own supply of oxidizer. A jet engine uses atmospheric air, but must be moving forward. The pulse jet is a jet engine that develops thrust without moving forward. The V-1 accomplished this with a carefully selected diameter and length of the exhaust pipe, to achieve resonance. It was limited in performance, as there is almost no compression of the air. Pulse jets can't usually take off on their own, due to limited power production at low speeds. The V-1 used a launch catapult. Robert Goddard did a pulse jet project in 1931, and used it on a his rocket powered bicycle.

Famed rocket scientist Werhner von Braun contributed to rocket projects besides his V-1 and V-2. He supplied rocket motors to other experimenters, and he proposed a vertical take-off interceptor plane. It was initially planned to launch from a dedicated building holding multiple aircraft, later modified to being launched from a transport truck It would have a pressurized cockpit, and was designed to glide back to a landing. It was to have a service ceiling of 8,000 meters, with a cruise speed of 690 km/hr. It was never built.

German Saenger II

This was a proposed two stage to orbit winged spaceplane project in the 1980's, by the German Hypersonics Programme. It was to mass 366,000 kg, and have a thrust of 4,500 kn. Studies were done at Messerschmidt-Bolekow-Bloehm. The first stage used a horizontal take-off, using a turbo-ramjet. The engine was built, and ground tested. The conclusion was that it would be very costly to develop, and showed minor cost advantages over the Ariane launch vehicle operationally. The project was canceled because of this.

The *Horus* winged second stage would have used a liquid oxygen/liquid hydrogen engine, with a thrust of 1,280 kilo-newtons. It was to carry 3,000 kg and two crew, or no crew and 15,000 kg.

Soviet Union

Both the Soviets and the allies captured some of the German rocketplanes, and these units had an influence on post-war rocket planes. The Soviets found five Junkers 126 pulsejet prototypes in a factory in their zone of occupied Germany. Unfortunately, their pilot was killed during unpowered testing.

Soviet rocket plane development had kicked off in 1932, with Korolev's GIRD-6 Project. He developed the Rp-318-1 rocket plane that flew in 1940. Korolev went on to lead the Soviet rocket programs during the Cold War, and saw Cosmonauts flying to space on his rockets.

*Early U. S. and Allied effort***s**

The first American crewed rocket flight had taken place in August of 1941, using a commercial airframe, the *Ercoupe*, and solid propellant rockets. The plane maintained its piston engine, but could take-off using either or both. This lead to development of rocket-assisted take-off for heavy bombers. This was under the guidance of Dr. Theodore von Karman. The pilot was Army Air Force Captain Homer A. Boushey.

The next effort involved a futuristic looking flying wing design, the Northrop MX-324. This used a liquid fuel engine, but it was too under-powered to take off on its own. It was towed to altitude by a P-38 fighter. But, in 1944, the Army Air Force let a contract to Bell Aircraft for the first really successfully rocket powered aircraft built in the U.S. This was the X-1, which would go on to be the first to break the sound barrier. This would also kick off the military's X-plane Project, which covered all sorts of experimental aircraft.

The British put large solid fueled rockets on Hawker Hurricane piston aircraft, and these could take off from a small ramp installed on merchant ships. This provided protection against enemy submarines and aircraft. The plane could not be recovered unless they were close to land, and the pilot needed to parachute out.

The prototype of the Messerschmitt P.1101 was about 80% complete when the Americans captured it. It was taken back to the States and studied. It influenced the design of the Bell X-5.

X-1

The Bell X-1 was the first plane to exceed the speed of sound in controlled flight, controlled by Chuck Yeager. It was designed and built in 1945. The German war effort in 1944 brought rocket-powered fighter planes to production and deployment, but there was not much know about the transition region to faster-than-sound flight. England, starting in 1942, also began to develop a faster-than-sound aircraft.

The X-2 *Starbuster* came out in 1955, a joint project by Bell, the U.S. Air Force, and NACA. It could go faster than the X-1 (Mach 3), and was used to investigate trans-sonic aerodynamic heating. It's engine, the XLR-25, was throttle-able. It was dropped launched from a B-50 bomber. It's first, unpowered flight went well, but an in-flight explosion while still attached to the mothership killed the pilot and

one crew member in the mothership. The first powered flight occurred in 1955. The first flight above Mach 3, a virtually unknown flight region, also killed the pilot. Exploration of this realm was postponed until the X-15 was ready for flight.

The X-5 was based on the World War-II P.1101 Messerschmitt. It included wing sweep adjusted in flight. A P.1011 was recovered by U. S. troops in 1945. The X-5 proved to be a problem, that sometimes went into an uncontrollable spin. One of these incidents killed the pilot. Two were built by Bell, the other now residing at the National Museum of the United States Air Force.

X-15

The X-15 was a crewed hypersonic aircraft, designed to fly to the edge of space, defined as 100 km . A pilot who reached this altitude was officially an Astronaut. The X-15 was carried to altitude under the wing on a B-52 Mothership. After it was released, its rocket engine was ignited, pushing it up out of most of the atmosphere. There were no air breathing engines. It did a “dead-stick” landing. There were two flights to the 100 km altitude, both by Joseph A. Walker in 1963. The X-15 flights were USAF, U.S. Navy, and NASA (previously, NACA) sponsored.

The X-15 was developed from a concept by Dr. Walter Dornberger for NACA in 1954. He was one of the captured German scientists that formed the core of the rocket team. Dornberger served as the military officer in charge of the German rocket program, and came to the U.S. with von Braun.

The follow-on to the X-15 was to be the X-15B. Rather than riding a B-52 mothership, it would sit atop SM-64 Navaho missiles, and be launched vertically. The X-15B program was canceled when NACA was dissolved, and NASA took its place, right after the Soviet launch of the first satellite. NASA chose the capsule rather than the spaceplane format. The work on the X-15B was recast as the Dyna-soar.

The Brass Bell Project was joined with the Dyna-soar program in

1957. Brass Bell, Project WS-459L, was to be a manned combat spacecraft. The Project was started in 1956, under NACA. There had been an earlier project, BOMI, involving a missile launched from a bomber aircraft.

Up to this point, both the Navy and the Air Force had man-in-space programs. Both of these were transferred to the Civilian Agency, NASA. These projects transitioned into the Dyna-Soar.

X-20

The X-20 Dyna-Soar was an Air Force project for a military manned reconnaissance space plane. They did not rule out it being armed. Around $600 million was spent on the project from 1957 through 1963.

Dyna-Soar was a USAF Project with a winged spacecraft. It was developed by Boeing as the X-20. The project started in 1957, and was canceled in 1963, just at the beginning of construction. The trend in spacecraft went to space capsules that had heat shields, and returned on a ballistic trajectory to a ground or water landing. Dyna-Soar was designed to reach Earth orbit with a single pilot, using a Titan launch vehicle. It had an equipment compartment behind the pilot, that could be used for payloads. A variant, the X-20X had a rear crew compartment that could hold 4. It was reusable, like the Shuttle would be. Both included a trans-stage at the rear for orbital maneuvering, that would be jettisoned before reentry. The plane could dip into the atmosphere and back to change its orbital inclination, without a large expenditure of fuel.

The project went back to Dr. Dornberger, from the German World War-II rocketry efforts, now in Huntsville. He had detailed knowledge of Eugene Sanger's Silbervogel Spaceplane project. The Dyna-Soar was modeled on that. Quite a few studies were done by the major U. S. Aerospace companies. This was to be a successor to the X-15 research vehicle. The contract to build the vehicle was awarded to Boeing. Later in the program, seven astronauts were chosen from NASA and the Air Force to fly the Dyna-Soar, including

Neil Armstrong. No manned flights were made.

In retrospect, the program was canceled due to uncertainty over the booster to be used, and a lack of planning and clear goals. The program kept changing requirements, and thus no one agreed on what to build. The Dyna-Soar did influence the later Space Shuttle design and operations.

Dyna-Soar was to be some 35 feet long, with a 20 foot wingspan. Its empty weight was around 10,400 pounds. It was to be able to achieve 17,500 mph, and a 22,000 mile orbit.

Despite cancellation of the X-20, the affiliated research on spaceplanes influenced the much larger Space Shuttle. The final design also used delta wings for controlled landings. The Air Force continued research into lifting body rockets, in a program called Spacecraft Technology and Advanced Re-entry Tests (START). An SV-5 vehicle was flown from the Pacific Test Range (Vandenburg AFB) to a point some 4,400 miles downrange.

X-24 Rocket Plane

The X-24A was a lifting body design. It was built by Martin Marietta, and taken to altitude by a B-52 mothership. It was used to prove concepts for unpowered landings later used by the Shuttle. First flight was in 1969, and continued through 1975. There was only one plane built, but it was extensively rebuilt by Martin, and renamed X-24B. This was a joint NASA-USAF Program.
The craft used the Reaction Motors XLR-11rs engine, capable of nearly 8,500 pounds of thrust. The A model was flown 28 times at speeds exceeding 1,000 mph, reaching 71,000 feet. There was a proposed X-24C which did not make it off the drawing board.

Similar aircraft from Northrop, the M2-F2, M2-F3, and HL-10 flew in 1966-67, with similar engines. These influenced the design of the Dreamchaser from Sierra Nevada. The HL-10 is on display at the entrance to the Armstrong Flight Research Center, at Edwards AFB, California.

X-33 and X-34

The X-33 was Lockheed Martin's Unmanned demonstrator suborbital spaceplane for NASA. It was the technology demonstrator for the VentureStar single-stage-to-orbit spaceplane. It was validating the concepts of a single stage to orbit, reusable launch vehicles, and seen as a Shuttle replacement. Lockheed Martin was the proposer. It was, essentially, a larger X-33. This project was canceled, and NASA chose to develop the Orion capsule instead of a new spaceplane.

Orbital Sciences developed the X-34, a pilot-less reusable launch vehicle with a spaceplane form factor. There were two demonstrators built, and submitted to towed and captive flight tests. The units are in storage at Edwards AFB.

X-37

Also known as the Orbital Test Vehicle, this program was originally a NASA Project, later assigned to the Department of Defense. The Boeing X-40 was a test platform for the X-37.

The USAF's X-37 Orbital Test Vehicle is launched on top of a booster, in a fairing, like a satellite payload to orbit. It is fairly small. Aerodynamic surfaces such as wings and a tail are not great for vertical flight. In 1999, this was a NASA Project, later transferred to the Air Force. There was a drop test of the vehicle at Edwards Air Force Base in 2006. It was launched to space in 2010. It spent 8 months in orbit, returning successfully, and validating the ceramic heat shield, and landing procedures. Since then, missions have flown from both the Kennedy Space Center, and Vandenburg Air Force Base, the latter used for polar orbits.

It flew to orbit September, 2017, on a Space-X Falcon 9. The Falcon booster returned to the its landing site at Kennedy. It was in the path of Hurricane Irma, and was hastily towed to the processing facility.

It is fully autonomous in operation, not requiring a crew for orbital operations, or reentry and landing. It is some 29 feet long, with a

wingspan of about 15 feet. The maximum take-off weight is 11,000 pounds. The payload bay is 7x4 feet. It is designed for up to 270 days in orbit.

The original intent was to carry the plane to orbit in the Shuttle's Cargo Bay. Since the Shuttle fleet was retired, it now rides a booster rocket to orbit, Delta IV or Atlas V. As a DoD Project, many of the aspects of the space plane are classified. It has been lifted by the Scaled Composites *White Knight* aircraft, for an atmospheric drop test. The carrier aircraft with the X-37 attached, unlike the earlier X-15/B-52 combination. This was demonstrated after a data link failure. A specific Air Force variant was developed from the NASA X-37, called the X-37B. It is designed for an orbital stay time of up to 270 days. The plane can land on the Shuttle runway at Kennedy Space Center, and can also return to Vandenburg. The plane achieves Mach 25 upon reentry.

Its Aerojet engine develops 6,500 pounds-force. There is now a "C" variation in planning with the capability of carrying up to six astronauts in a pressurized cargo compartment. There would be no onboard pilot. The NASA Project is managed by the Marshall Space Flight Center in Huntsville, Alabama. This space plane may form the initial capability of Space Force.

Boeing MX-2145

The Boeing MX-25 was a planned manned boost-glide bomber. It would be launched as a rocket, fly to its target, and return to base. This was a project of Boeing and the Rand corporation in 1954, never completed.

Blackstar

The Blackstar program was a classified orbital spaceplane. It supposedly was operated by the U. S. National Reconnaissance Office, not the Air Force. It was a two stage to orbit vehicle, with a mothership called the SR-3, perhaps a modified North American B-

70, and the rocket-powered payload, the XOV (experimental orbital vehicle). The XOV was similar to he X-20 Dyno-soar, with an aerospike engine, which is a rocket without a nozzle. The XOV could land on a standard runway.

Space Command

The United States Space Command, re-established in August of 2019, is a command organization of the U. S. Department of Defense. It was originally established in 1985 with the mission to coordinate the military uses of space of the Air Force, Army, and Navy. Space commend has the responsibility for space warfighting.

Since the very beginning, there has been "conflict" between the military and civilian agencies on the space domain. Initially, the Army and the Navy competed against each other to launch the first satellite. NASA, a civilian agency, was formed in 1958 to handle all non-military space activities. Winged spacecraft, such as the X-15 were Air Force Projects.

Space Command, formed as the 11th geographic combatant command, is intended to get the military into a domain it has wanted to be in. We can see the possibilities of combat extended into space, as many space assets such as navigation, weather, and observation systems are essential now to ground, sea, and air combat. Left unsaid is potential combat in space against extra-terrestrials. If that occurs, we would certainly be outgunned, as they would have to come to us from great distances, and have superior technology. At the moment, there is no generally accepted credible evidence of any extraterrestrials with designs on our habitat.

The follow-on to Space Command is to establish a Space Force, ready to dominate the space environment for the United Space. Based on past scenarios, this will lead to the development of Space Forces by other space-faring nations.

At this writing, the Air Force has selecting a site for Space Command Headquarters, Peterson Air Force Base in Colorado.. The first project may be the establishing a permanently manned lunar base.

Essentially, grasping the high ground. The biggest challenge will be in the design of the Space Forces uniform, of course. It is unclear if Space command would take over the roll of planetary protection from asteroids and such, from NASA.

Space Command is already war-gaming numerous scenarios, with the 13th Schriever Wargame, as this book is wrapping up. Schriever Air Force Base in Colorado is the home of the 50th Space Wing. They are responsible for 175 DoD satellites. The base is also the master control station for the GPS satellite system. The war gaming covers various scenarios such as missile attack, service denial due to an atomic explosion in orbit, and other bad things. It is not known whether military action against Extra-terrestrials is included.

Space Force

Space force is a military unit that is responsible for conducting combat operations in space. The is no such known organization at the current time, but planning was started in 2018. The Russians had a Space Force in 1992, merged into their Strategic Missile Force in 1997. It was made an independent organization again in 2001, only to become the Russian Aerospace Forces under the Russian Aerospace Defense Forces. Not to be outdone, China established the People's Liberation Army Strategic Support force. The U., S. Department of Defense see Space Force relating to the Air Force, as the Marines relate to the Navy. There would be an undersecretary of the Air Force3 for Space created.

The military activities in space have followed a complex path.

Air Force Space Command

The Air Force Space Command is a major component of the U. S. Space Command. It has its Headquarters at Peterson Air Force Base in Colorado, and has units at 88 locations world wide. The command consists of some 38,000 personnel. One of the major responsibilities is intercontinental ballistic missiles.

Activities began in 1982 to consolidate missile warning, and to oversee launch operations. It also has oversight of GPS, military weather satellites, and anti-satellite technology. The X-37 Spaceplane, discussed earlier is under this command. They oversee military launch operations at Vandenberg and Cape Canaveral. The Command oversees launch services provided by three contractors, Blue Origin, Northrop Grumman, and United Launch Alliance.

They also oversee space situation awareness using the Air Force Satellite Control Network, ground-based optical tracking facilities, and both passive and active surveillance. Missile warning systems have been in place since 1957.

DoD's Role, NORAD

Orbital Debris is tracked by radar. NORAD, the North American Aerospace Command, based in Colorado, tracks all detectable orbital entities, from large satellites to space junk, zombie-sats, and the larger pieces of debris, as well as near-Earth asteroids. The U. S. Space Surveillance Network can see objects 10 cm. or larger. U. S. Space Command deployed a new large telescope to improve their view of debris in 2011. This Space Surveillance Telescope is able to see debris at Geosynchronous altitudes. It has a 3.5 meter mirror, and has been in use since 2011 in Australia.

NORAD puts all this data up on a website, in a standard format called the “two-line element” (TLE). This contains the Keplerian orbital elements, the set of data describing the orbit of anything around the Earth, for a given point in time (epoch). It is a legacy format from the 1960's, that still works. It includes two data items of 80 ASCII charters each (an IBM punch card format).

There are other tasks that Space Command could do. Defend the planet, for one. We are not talking about defending our planet against alien invasion. There are worse problems. Solar storms threaten our space, air, and land assets. Large asteroids hit the surface and explode with the power of atomic weapons. One of these could be mistaken

for a nuclear weapon, and cause a deadly exchange.

An NEO is a solar system object whose closest approach to the Sun is 1.3 AU, and that comes in close proximity to the Earth There are 15,000 known asteroids in this category, 100 comets, some solar orbiting spacecraft, and meteoroids. All these have the potential of striking the Earth. They are closely tracked from the ground, by NASA's Planetary Defense Coordination Office.

The Minor Planet Center collects all the world wide observational data for minor planets (asteroids and comets) and maintains a database. It is located at the Smithsonian Astrophysical Observatory, at Harvard University. It maintains an NEO website and blog. At this writing it has a total of 524,000 minor planets, attributed to more than a thousand astronomers at more than 200 institutions.

A Potentially hazardous asteroid (A PHA is defined by its potential to come close enough to Earth to pose a threat. This is determined by an Earth minimum orbit insertion distance of 0.5 AU or less (around 7,500,000 km) and an absolute magnitude of 22 or less. What's the significance of the magnitude? We assume an albedo of 14%, which would give a diameter of 140 meters or so. Usually the asteroid can't be imaged or resolved in the telescope.

Can the United States be hit by a significant meteor? I suggest you visit Barringer, or Meteor, Crater located northeast of Flagstaff, Arizona, a short drive. It puts the fear of meteorites into you. It was originally thought to be the result of a volcanic eruption, but was recognized in 1905 as an impact crater, and named after the guy who figured it out, Daniel Barriger. Not in my back yard!

Orbital debris is becoming major problem. It can be naturally occurring rocks and captured meteoroids. It can come from satellites collisions and explosions. Liquid fuel, from a dead satellite or leakage, freezes in space and provides yet more debris problems. There have been 5 known collisions of satellites in orbit so far.

All of the junk, down to the size of bolts, is tracked by the U.S. Air

Force. They know of 18,000 objects in orbit, of which 1,400 are operational satellites. A good job for a robotic servicer in LEO would be to collect the trash, put it in a canister, and kick it off to re-enter and burn in the atmosphere. There are estimated to be 170 million chunks, smaller than a centimeter, any of which can ruin your mission.

There have been on-orbit tests of anti-satellite weapons, by the U.S., Russia, and China which resulted in a large amount of debris. This is a really bad idea.

NASA says that at least one piece of space debris falls to Earth daily, and has for the past 50 years. There have been injuries, such as the Japanese fishermen hit in 1969. A lady in Oklahoma was hit by a piece of debris in 1997 but was not injured. This turned out to be a pieces of a Delta-II rocket propellant tank.

Zombie sats are non-functioning satellites in orbit. They may have experienced a failure, and are no longer functional. They remain in the same slowly-decaying orbit, however. The Intelsat Galaxy-15 is an example. It was in geostationary orbit when the ground lost control, and it began to drift. There was a potential of collision with other, operating satellites. Later, control was recovered, and it was directed back to its correct orbital position.

Planetary defense is being addressed at the highest levels of the U.S. Government. The National Science and Technology Council is part of the Executive branch. Under this is the Office of Science and Technology Policy, charged with providing advice to the Executive Office. There has been established A Damien Inter-Agency Working Group, where Damien is an acronym of “Detecting and Mitigating the Impact of Earth-Bound Near-Earth Objects.” In government, it is important to have an awesome acronym.

The National Near-Earth Object Preparedness Strategy and Action Plan is a document that address the topic of Planetary Defense over a ten year span. It is used to co-ordinate efforts among government

agencies. The plan has five major goals. The first is to focus on NEO detection, tracking, and characterization. The second goal is to improve models and prediction, and to address Information integration for decision making. The third goal is to develop technologies for NEO deflection and disruption. NASA is the lead for this effort. The fourth goal is to increase International Cooperation on NEO Preparedness. This will involve International support and education. The fifth goal is to “strengthen and routinely exercise NEO Impact Emergency Procedures and Action Protocols.”

NASA has a Planetary Defense Officer, working with the Damien Group. Other members are from NIST, NSF, State Department, Homeland Security, USAF, the Lawrence Livermore National Laboratory, and others.

The USAF's Space Surveillance Network can track items as small as 10 cm in LEO, or 1 meter in GEO.

Wright-Patterson Air Force Base

The Wright-Patterson AFB in Ohio hosts the Air Force Material command, and is located where Orville and Wilbur Wright first began experimenting with manned flight. The Battelle Institute was a contractor for these efforts. Wright-Pat's Foreign Technology Division was in the business of examining and reverse engineering German and Japan's aircraft during World War Two, and Russian aircraft during the Cold war.

Since their focus is on foreign technology, they were the processing center for numerous UFO reports as well. Wright-Pat hosted UFO Study's Project Grunge and Project Blue Book. They had 12,618 sighting reports, with more than 700 unresolved when the program was shut down. These case files went to the USAF Historical Research Center, then to the National Archives and Records Service in Washington, D. C. The preferred term now is Unidentified Aerial Platform.

Wright-Pat hosted the Air Technical Intelligence Center during World War-II, under the Air Materiel Command. During the Korean War, it evaluated Russian MIG's that had been recovered after crashes. It also was the Air Force Investigation office for Unidentified Flying objects. The Intelligence center became the Foreign Technology Division in 1961with an Aerial Phenomena Office. It was able to study some Soviet spacecraft that had been recovered. In 2003, this center was re-organized as the National Air & Space Intelligence Center. As an aside, Wright-Pat also holds Nikola Tesla's papers.

Joint Functional Space Component Command

The Joint Functional Space Component Command is a component of the U.S. Strategic Command. It was established in 2006, and is headquartered at Vandenberg Air Force base in California. It was deactivated in 2017, and replaced by the Joint Force Space Component.

Naval Space Command

The Naval Space Command, was a military command of the U.S. Navy from 1983 to 2002, and a component of Space Command. It was based out of Dahlgren, Virginia in 1993. it was tasked with using space assets to support Navy missions. It became part of the Naval Network and Space Operations Command in 2002. The Naval Research Lab, in Washington, D. C. used their Minitrack system to track Soviet and American satellites.

In April 2019, the Navy acknowledged that it was drafting new guidelines for pilots and other personnel to report encounters with "unidentified aircraft."

Naval Space command assumed the responsibility of operating the alternate space operations center for Space Command. In 2004, the command was dissolved, and components went to the Air Force Space Command.

National Reconnaissance Office

The National Reconnaissance Office is an agency of the Department of Defense, and a member of the Intelligence Community. It operates a series of reconnaissance satellites in orbit.

United States Army Space and Missile Defense Command

This Army command was established in 1997. It is responsible for the Army component of DoD space operations. It was responsible for the use of space assets during Operation Desert Storm. It is manned by active Army and National Guard troops. One such Guard Unit is the Colorado 117th Space Battalion. There is now a Space and Missile Defense program at the U. S. Military Academy, West Point, New York.

The First Space Brigade, 2003, is tasked with "conducting continuous, global space support, space control and space force enhancement operations in support of U.S. Strategic Command and Supported Combatant Commanders enabling the delivery of decisive combat power."

National Reconnaissance Office

The U. S. National Reconnaissance Office is an Intelligence arm of the Department of Defense. It operates a series of satellites, and has personnel from the Armed Forces. It is considered one of the “Big Five” U. S. Intelligence Agency's, the others being the Central Intelligence Agency (CIA), National Security Agency (NSA), Defense Intelligence Agency (DIA), and National Geospatial-Intelligence Agency (NGA). NRO builds and operates the reconnaissance satellites of the United States, involving imaging and communications. It is also responsible for Space Launch Management, under directive 82-1a. NRO will support the U. S. Space Command.

The Central Intelligence Agency

The Central Intelligence Agency has long had interest and involvement in the UFO issue. In the Post-World War-2 era, and during the Cold War, there was a concern that UFO sightings could be linked to the Soviets. The CIA kept an eye on Air Force monitoring of events. In the 70's and 80's, the Agency maintained a slight interest in UFO sightings, and UFO's in general. From their perspective, they had to assume they were real, and could possibly be a threat. They were interested in anyone's “unconventional” aircraft.

Supposedly, Majestic-12 was a top secret committee created by President Truman in 1947 to collect UFO wreckage and potential alien body's.

Advanced Aerospace Threat Identification Program

This Program was started in 2007, but not made public until the end of 2017. It started out in the Defense Intelligence Agency, a project by Senator Harry Reid, spurred on by Robert Bigelow, now in the commercial aerospace market. The program generated a nearly 500 page report, covering world wide sightings. It has not yet been release to the public.

Bases in Orbit or on the Moon

This section discusses the establishment of military bases in orbit or on the Moon.

Project Horizon

Project Horizon was a 1959 Army study for a lunar base. NASA as a civilian agency was just on the horizon then, and the Army, Navy, and Air Force each had space plans. Horizon was conducted by the Army Ballistic Missile Agency. The lunar base was to protect U.S. interests on the Moon. Against whom, one could wonder. Were the

Soviets at the top of the list?

Several other goals were to use the moon as a communications relay (with that pesky 1 second round trip delay), a surveillance base, and to support military operations on the Moon, if needed. The Project was to establish and maintain a permanent outpost. It was supposed to be deployed by December 1966 to support 12 troops, at a cost of $6 billion. After the feasibility report, the project was canceled by President Eisenhower, and off-planet activities were assigned to the newly-created NASA.

Project A119

Project A119, “A Study of Lunar Research Flights”, was a 1958 Air Force Plan to detonate a nuclear weapon on the Moon. There were several well meaning reasons for this. First, as a show of force. Secondly, to study the effects of a nuclear explosion in vacuum and a lower gravity. This was headed up by Carl Sagan. The Russians were working on a similar project. The Project was not revealed until the year 2000. The original idea came from Edward Teller.

Cooler heads prevailed, and we did not bomb an extra-terrestrial target.

Alien Lunar Base

Based on NASA imagery, particularly that of the Lunar-orbiting Lunar Reconnaissance Orbiter, various alien lunar bases have been “discovered.” Others have turned up on Google Moon. So much for Alien stealth. Another issue is that a lunar base would most likely be underground, perhaps in capped lava tubes, to avoid large temperature swings between night and day, and as radiation protection. What has been interpreted as lunar bases have mostly been identified as “structural anomalies.” There are also Alien bases on Jupiter's Moon Europa. I would be the first in line to greet the aliens and visit their base, but I haven't seen that opportunity yet. In image analysis, sometimes you see what you want to see.

Lunex Project

Lunex was a USAF Project for a lunar base, in 1958. There was to be a lunar landing before the Apollo. The ambitious project called for a 21 person underground Air Force base on the lunar surface by 1968. The Lunex vehicle differed from the Apollo in that the Lunex would land the entire vehicle on the lunar surface. The Apollo only landed the lunar module, which separated in two when launched from the lunar surface. There would be, like in Apollo, a command and service module in lunar orbit.

Deep Space Gateway

The Deep Space Gateway (DSG) is a NASA Project for a crewed station in cis-lunar space. It is intended as a jumping-off point. The Orion crewed vehicle is scheduled to be used for this effort. The Gateway would be located in a halo orbit around the Moon. By that, we mean that the spacecraft would be visible to Earth for its entire orbital path. The DSG would form an in-orbit ecosystem for missions to the lunar surface, and to Mars. Ion thrusters are proposed for station-keeping. These use electrical power for accelerating various (usually, inert) gasses to high velocity, rather than using fuel and oxidizer. The thrust is generally low, but can be continued for long periods of time. The Gateway was going to be built for the Asteroid Redirect Mission. This mission was de-funded in early 2017. It had the goal of rendezvous with an asteroid, achieving lessons-learned applicable to planetary defense. The Military would probably follow a well-designed operational approach with a few years head start.

Transportation and Logistics

The radiation environment of Earth orbit is well understood. The crew on the ISS can operate for up to a year at the ISS, before accumulating a “life-time” dose. In additional Sentinel satellites give us a few days warning of solar storms, or Coronal Mass Ejections, that would allow the crew to enter a specially designed “storm shelter” for a few days. The situation at the moon is much different.

The moon has a weak magnetic field compared to Earth. The good news is, there is almost no trapped particles, like Earth's Van Allen Belts. The bad news is, the lack of an appreciable magnet field mean no protection from energetic charged particles. In cis-lunar space, there is a greater incidence of galactic cosmic rays. It is a similar situation at Mars. For Habitats at the Earth-Moon libration points, it is the same. Facilities on the lunar surface will probably be put under a layer of regolith. Another potential accommodation is within lunar lava tubes.

Away from our home planet with its convenient magnetic field and van Allen Belts, we have radiation issue with cosmic rays and the Solar proton wind, as well as transient events such as the CME. This will be addressed by locally obtained mass, from the lunar surface or asteroid, employed as bulk shielding. The shielding will also protect against space debris. Although a window may be pierced, the hole will generally be small enough to be ignored for a while, due to the large enclosed volume of air.

Colonies are best located near resources and energy sources. The energy resource is the Sun. The resources, in the short term are the moon and the asteroids. This approach was followed in 19th century iron manufacturing, where the iron furnaces were located near supplies of the raw materials, iron ore, limestone, and coal. Villages grew up around the iron works. It is cheaper to ship finished product than the raw materials.

Water ice is a valuable commodity. It has been observed in craters at the lunar south pole. It can be electrolized with abundant solar power into its constituent hydrogen and oxygen, and used as rocket fuel.

There also seems to be extensive amounts of Helium-3 in the lunar regolith, from the solar wind. Helium-3 is a potential energy source in nuclear fusion reactors. It has the nice property of releasing large amounts of energy, but little radiation.

Besides the asteroids, which mainly are found beyond Mars, there are also inactive or captured comets that contain water ice, and hydrocarbons. Jupiter's Trojan asteroids may have water ice in vast

quantities, which would make them ideal filling stations for interplanetary missions. Just need a bathroom, coffee machine, and some snacks.

Energy from the Sun is abundant, and amounts to about 1367 watts per square meter, at Earth's orbit. More as you go closer, less as you go further away, by an inverse square law. With current solar cell technology, solar panels can be used up to Jupiter, but not much beyond.

The Power/Propulsion Module (PPM) would have large solar arrays for power, 40 kW is baselined. The cis-lunar Habitation Module will join the PPM later in orbit, and will provide living and work space. The planned Gateway and Logistics module will join next, providing experiment space and supplies. An airlock module will be added later, to enable EVA operations. The DSG can also serve as a communications relay to and from Earth, for lunar and Mars missions. Telerobotic missions on the lunar surface can be accomplished now, but the communications delay is just on the edge of making it awkward. The communications time from the DSG to the lunar surface will be negligible. The DSG could also serve as the basis for a lunar GPS system, providing a location reference for surface rovers.

The Gateway will serve as a “enabling infrastructure” for further exploration. It is planned to be placed in a near-rectilinear halo orbit (NRHO) around the Moon The Gateway will serve as the starting point and the mothership for lunar exploration. The DSG offers return to Earth in a matter of days. If the lunar water ice can be successfully mined and broken down into hydrogen and oxygen, we will have a fueling station that is not on the Earth's surface. With lunar surface exploration by autonomous and telerobotic rovers, mining for minerals can also be accomplished.

UFO

A UFO is exactly an “unidentified flying object.” We don't know what it is, so it is unidentified. We might be able to figure it out – it

could be an aircraft, a cloud, a missile, space debris, etc. A UFO is NOT necessarily an alien spacecraft. If we knew that, it is identified, right?

The Air Force has a more formal definition, in its USAF Regulation 200-2 of 1953. It defined them as "...any airborne object which by performance, aerodynamic characteristics, or unusual features, does not conform to any presently known aircraft or missile type, or which cannot be positively identified as a familiar object."

In April 2019, the Navy drafted new guidelines for pilots and other personnel to report encounters with "unidentified aircraft." This makes analysis easier.

Project Blue Book

Project Blue Book was an Air Force study starting in 1952. It was a systematic study of unidentified flying objects. During the Cold War, we needed to be able to identify whatever we saw, because it could been a nuclear-tipped Russian missile. We got good at that, but there was still a category of things that were detected, but not identified. That is to be expected, but we kept improving the process. The goals were to determine if UFO's posed a threat to National security. And to analyze the available data to identify what was unidentified. The Project was shut down in 1969.

The Air Force produced a report that was reviewed by the National Academy of Sciences. The Document, called the Condon Report, said that "No UFO reported, investigated, and evaluated by the Air Force was ever an indication of threat to our national security," There was no evidence submitted to or discovered by the Air Force that sightings categorized as "unidentified" represented technological developments or principles beyond the range of modern scientific knowledge," There was no evidence indicating that sightings categorized as "unidentified" were extraterrestrial vehicles." There you go.

The Air Force supposedly sent all Blue Book Records to the USAF

Archives, Maxwell AFB. From there, in 1976, the files went to the National Archives and Records Administration. The files are openly available without restriction. Some names were redacted.

The Condon Report was a product of the Condon Committee, a University of Colorado UFO Project, funded by the Air Force from 1966-68, headed by Edward Condon, Physicist. It had 12,618 UFO reports. Remember, this was not 12,618 sightings of a flying saucer, but 12,618 detection's of something flying that was not identified. A lot of these were thought to be weather phenomena or aircraft. A small percentage of reports were considered unexplained, as there was not enough specific data. The report was released under the Freedom of Information Act, and can be purchased in book form.

There was and still is skepticism about the conclusions. Perhaps the Air Force did discover evidence of extra-terrestrials, and decided to keep it secret. This Conspiracy theory could be true, and many wish to believe in extra-terrestrials, and seek confirmation.

Project Sign

This was an Air Force study in 1947-48. It concluded that a lot of the unidentified objects could not be identified due to lack of data. The Sign report did argued in favor of a extraterrestrial origin for UFOs. The Air Force documents were declassified in 1961, and are available.

Project Grudge

This was an Air force study in 1949, following Project Sign. This was to proceed as an “unbiased evaluation of intelligence data.” This was an improvement over the *Sign* approach. The 600 page Grudge report said:

“ There is no evidence that objects reported upon are the result of an advanced scientific foreign development; and, therefore they constitute no direct threat to the national security. In view of this, it is recommended that the investigation and study of reports of

unidentified flying objects be reduced in scope. Headquarters Air Material Command will continue to investigate reports in which realistic technical applications are clearly indicated."

"All evidence and analyses indicate that reports of unidentified flying objects are the result of:

1. Misinterpretation of various conventional objects.
2. A mild form of mass-hysteria and war nerves.
3. Individuals who fabricate such reports to perpetrate a hoax or to seek publicity.

In the "Fort Monmouth Incident" of September, 1951, there was a radar/visual UFO encounter. Pilots and radar operators reported encounters with a number of fast-moving, highly maneuverable disc-shaped aircraft." this was never satisfactorily resolved.

Roswell Incident

The most important UFO incident happened at Roswell, New Mexico just after World War-2, in 1947. The Air Force sent out a press release that said,"..a flying disc had been recovered near Roswell, New Mexico... ". This was quickly followed by a second press release revealing it was a weather balloon. You couldn't have asked for a better way to kick off a conspiracy theory that has been around to the present day. Many have claimed to have seen alien bodies and a saucer-shaped craft. Many go on to claim that we were able to reverse-engineer many of their technologies, and hasten the development of advanced computers and lasers. It went so far as the former commander of Wright-Patterson Air Force base, a Brigadier General, said the saucer had been taken to Wright-Patterson AFB for evaluation.

Russian Space Command

The Russian Space Command was formerly part of the Russian Aerospace Defense Forces, tasked with military space-related

activities. In 2011, the Russian Space forces merged with the Russian Air Force. They have the same goals that the United States does, defending against ballistic missiles and Near Earth Objects. They have been smacked with large meteorites at least twice in the past.

A meteor entering the Earth's atmosphere can cause an explosion. These may have started out as asteroids in space. The extreme example is the 1908 Tunguska Event in Siberia, an explosion equal to an atomic weapon. In 2013, the Chelyabinsk meteor event, also in Russia, was widely photographed, and went viral on the internet. The meteor size was estimated to be 25-30 meters, and it came in at 55,000 km/hr. No defense against that, except to run. More than a thousand were injured. A big problem is mis-identifying such an event as a nuclear attack.

Asteroids of up to 4 meters in size impact the Earth about once per year, with 3 kilotons of energy. Asteroids of up to 70 meters impact every 1900 years or so, with an energy of 16 megatons (TNT equivalent). These can trigger extinction events. We have evidence of one of these impacts at Meteor Crater in Arizona.

The Russian Space Forces were originally formed in 1992. Space Forces operated the launch sites in cooperation with the civilian Federal Space Agency.

The Russian Zvexda lunar base project in 1962-74 was to be an extension to the manned lunar expedition. Before 1980, all aspects of the Russian Space Program were classified as top secret.

Outer Space Law and Agreements

With the United States, Russia, China, India, and the countries comprising ESA, there are quite a few countries engaging in space activities. The United Nations have been the lead in the interaction of countries in Space.

Specifically for the Moon, there is the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, better

known as the Moon Treaty in 1979. This has been signed by 17 countries. This says that “no nation may claim sovereignty over any part of space. All countries should have equal rights to conduct research on the moon or other celestial bodies.”

In addition, “All activities in space are required to be attached to a nation and any damages to other nations equipment or facilities caused by another party must be repaid in full to that nation.” Thus, private company's must seek licenses from the relevant agency of their local governments to conduct space operations.

From the UN Committee on the Peaceful Uses of Outer Space, based on the International Law of the Sea, there have been derived five international treaties. These are:

- The 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the "Rescue Agreement").

- The 1972 Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention").

- The 1975 Convention on Registration of Objects Launched into Outer Space (the "Registration Convention").

- The 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Treaty").

- The 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (the "Outer Space Treaty").

A total of 104 countries have agree to and signed the Outer Space Treaty. There are now more than 35 national civilian space agencies.

Exopolitics

Exopolitics refers to engagement with alien entities, if that were ever necessary. It would be good to go through the motions, in the event we really need it some day. The major areas are international relations, security, and military uses of space.

If we can use the New World, the Western Hemisphere, as an example, we have not been the best “aliens” from the view point of the indigenous peoples. If the situation arises, how will Earth be treated by the obviously technologically superior “aliens”?

Post-Detection Policy

A lot of thought by a lot of very smart people have given thought to how we handle first contact with another intelligent race. We may never need this, but it doesn't hurt to have it thought through. The protocol defines a set of rules, standards, guidelines,and actions. The guidelines and their application are guided by three factors, a judgment of society's readiness to accept the news, how the news is released and by whom, and the comprehensiveness of the signal. We are assuming the detection of a signal of extraterrestrial origin is the trigger, not a saucer sitting down on the White House lawn.

Keep in mind, at the present time, there is no empirical knowledge of extra-terrestrial life. We could at any time receive a coherent signal of extra-terrestrial origin, find evidence buried on Earth, deep in the oceans, under the ice caps, or discover evidence on the moon, Mars, or the Moons of Jupiter or Saturn.

The International Academy of Astronautics maintains a Permanent Study Group refining and updated op\procedures. The purpose of the Group is to have a set of suggested guidelines when an event occurs.

Planetary defense

One of the tasks that Space Command would probably take over from NASA is planetary defense. This section is excepted from the

Authors book on that Title.

This is not for the purposes of repelling an alien invasion, although the military has probably planned for that. Any civilization that could reach us is undeniably more technological advanced.

We are focused, however, on big chunks of rock that could cause massive damage, and end civilization as we know it. It has happened – ask the dinosaurs. Ocean impacts, and Earth is covered by 75% water, recall, could trigger massive Tsunamis.

The U. S. National Science and Technology Council is on record as saying we are unprepared as a nation for a large asteroid impact event. The last impact of a object some 10 km in size, 66 million years ago, caused an “extinction event.”

A four meter asteroid enters the Earth's atmosphere about once a year. For seven meters, its 5 years. That size produces a Hiroshima-sized explosion. For 20 meter asteroids, its twice per century. We just had one in 2013. We have had a success rate of four asteroids detected before they hit Earth's surface. It's the ones we don't detect that should trouble us. That, and the fact we don't have a clue on what to do about it, if its detected.

About 100 tons of stuff enters the atmosphere every day as dust (and settles on my car...). On average, we get about 30 entries of smaller items, most of which burn before they hit the ground.

What do we have to defend against? A wide variety of Near-Earth Objects, a bunch of space debris in orbit that we are responsible for, radiation blasts and chunks of the Sun, lot of stuff out there that gets caught up in Earth's gravity, or that we cross paths with. We are better than we were at detection. It remains to be shown if we are any good at deflection. It's high stakes.

There are worse problems. Solar storms threaten our space, air, and land assets. Large asteroids hit the surface and explode with the

power of atomic weapons. One of these could be mistaken for a nuclear weapon, and cause a deadly exchange. We don't need aliens to obliterate us, we can do that ourselves.

NEO

An NEO is a solar system object whose closest approach to the Sun is 1.3 AU, and that comes in close proximity to the Earth There are 15,000 known asteroids in this category, 100 comets, some solar orbiting spacecraft, and meteoroids. All these have the potential of striking the Earth. They are closely tracked from the ground, by NASA's Planetary Defense Coordination Office. A joint US/EU project called the Spaceguard Program is tracking NEO's larger than 30 meters. Three NEO's have been visited by spacecraft. NEA's are grouped into one of four categories, based on their perihelion, aphelion, and semi-major axis.

There are four groups of NEO, named for the first member observed. Group Atira has members whose orbits are contained within the orbit of the Earth around the Sun. Group Aten are Earth-crossing, with a semi-major axis smaller than Earth's. Group Amor is between the Earth and Mars. Group Apollo asteroids have a semi-major axis larger than Earth's.

If NEO's enter the atmosphere, they heat up and burn. Sometimes, enough is left to hit the ground, appearing as a rock.

The Minor Planet Center collects all the world wide observational data for minor planets (asteroids and comets) and maintains a database. It is located at the Smithsonian Astrophysical Observatory, at Harvard University. It maintains an NEO website and blog. At this writing it has a total of 524,000 minor planets, attributed to more than a thousand astronomers at more than 200 institutions.

Potentially Hazardous Asteroids

A PHA is defined by its potential to come close enough to Earth to pose a threat. This is determined by an Earth minimum orbit insertion distance of 0.5 AU or less (around 7,500,000 km) and an absolute

magnitude of 22 or less. What's the significance of the magnitude? We assume an albedo of 14%, which would give a diameter of 140 meters or so. Usually the asteroid can't be imaged or resolved in the telescope.

Space Debris

Sometimes we are out own worst enemies. Orbital debris can come from many sources. It can be naturally occurring rocks and captured meteoroids. It can come from satellites collisions and explosions. Liquid fuel, from a dead satellite or leakage, freezes in space and provides yet more debris problems. There have been 5 known collisions of satellites in orbit so far.

All of the junk, down to the size of bolts, is tracked by the U.S. Air Force. They know of 18,000 objects in orbit, of which 1,400 are operational satellites. A good job for a robotic servicer in LEO would be to collect the trash, put it in a canister, and kick it off to re-enter and burn in the atmosphere. There are estimated to be 170 million chunks, smaller than a centimeter, any of which can ruin your mission.

There have been on-orbit tests of anti-satellite weapons, by the U.S., Russia, and China which resulted in a large amount of debris. In addition, failed on-orbit rendezvous usually involved a low speed collision, and more debris creation. There was the 1996 collision between the French Cerise military reconnaissance satellite and debris from the Ariane launch vehicle. There was the 2013 collision between debris from the Chinese Fungyun FY-1C satellite and the Russian BLITS nano-satellite. We should also mention the 2013 collision between two CubeSats, Ecuador's NEE-01 Pegaso and Argentina's CubeBug-1, and the particles of a debris cloud around a Russian Tsyklon-3 upper stage from the launch of Kosmos 1666. A 1985 U.S. Anti-satellite test created thousands pieces of debris greater than 1 cm. Most of this reentered the atmosphere within 10 years. Some of it is still in place.

Zombie Sats

Zombie sats are non-functioning satellites in orbit. They may have experienced a failure, and are no longer functional. They remain in the same slowly-decaying orbit, however. The Intelsat Galaxy-15 is an example. It was in geostationary orbit when the ground lost control, and it began to drift. There was a potential of collision with other, operating satellites. Later, control was recovered, and it was directed back to its correct orbital position.

The first U. S. satellite, Vanguard-1, and its upper stage are still in-orbit. It was launched in 1958. The Soviet-era RORSAT, with its BES-5 nuclear reactor, is still in orbit. In 2015, the USAF Defense Meteorological Satellite (Military equivalent of the GOES weather satellite) exploded in orbit, creating some 150 chunks of satellite in orbit.

Of the 7,000 or so satellites placed into Earth orbit so far, 1,500 are still functioning. The rest are Zombie-Sats. Other sources of Zombie-sats is booster debris, from the launch vehicle upper stages.

Meteor Airburst

A meteor entering the Earth's atmosphere can cause an explosion. These may have started out as asteroids in space. The extreme example is the 1908 Tunguska Event in Siberia, an explosion equal to an atomic weapon. n the 500 kilotons area.

Asteroids of up to 4 meters in size impact the Earth about once per year, releasing the equivalent of 3 kilotons of energy. Asteroids of up to 70 meters impact every 1900 years or so, with an energy of 16 megatons (TNT equivalent). These can trigger extinction events. The one that caught the dinosaurs off guard was probably 10 kilometers in diameter. In 1949, the same region was treated to a meteor shower, with no damage reported.

An extinction event is defined as “a widespread and rapid decrease in the amount of life on Earth.” Given that over 98% of the species we

know of are extinct, we need to be careful with the home planet. There have been several mass extinctions on Earth since life began, none because of us. So far.

There was a documented case in 1490 in China, *the Ch'ing-yang event*, that resulted in 10,000 deaths. It was an extremely bright bolide, that usually explodes in the atmosphere. It can also result in a crater-forming event.

The Earth Impact Effects Program characterizes the average energy of airbursts, and the average frequency of the event. This ranges from a 4 meter, 0.7 kiloton airburst every every 1.4 years, to a 70 meter, 15 megaton event, every 1900 years.

The Chelyabinsk Meteor airburst occurred shortly after dawn in February 15, 2013. That city in Russia is located near the border of Europe and Asia. The meteor came in at 34,000 miles per hour over the Ural Mountains, and exploded somewhere around 16 miles from the surface. The height of the explosion limited damages to the town, which were extensive enough as it was.

Chelyabinsk meteor event was widely photographed, and went viral on the internet. The superbolide was estimated to be 20 meters in size. The air burst occurred around 30 kilometers altitude, causing a large shock wave, and scattering small fragments over a large area.

In this event, some 1,500 people were injured enough to seek medical help. More than 7,000 buildings in the area were damaged, mostly by broken windows. The bolide was estimated to mass some 12,000 metric tons, and measure about 20 meters in diameter. It was a total surprise, and had not been observed or tracked before it exploded. The explosion was detected by monitoring stations of the Nuclear Test ban organization. The sound waves went around the planet several times. A weather satellite caught a picture of the meteor entering the atmosphere, and it was found later.

The immediate effect was a flash as bright as the sun, and a shock

wave that injured over a thousand, and blew out windows for miles. The visitor was estimated at some 50 feet in diameter, massing around 10,000 tons. The effective power of the explosion was 500 kilotons of TNT.

What are we doing now about planetary defense?

U.S. National Space Policy directs the NASA Administrator to:

"pursue capabilities, in cooperation with other departments, agencies, and commercial partners to detect, track, catalog, and characterize near-Earth objects to reduce the risk of harm to humans from an unexpected impact on our planet."

Planetary defense is being addressed at the highest levels of the U.S. Government. The National Science and Technology Council is part of the Executive branch. Under this is the Office of Science and Technology Policy, charged with providing advice to the Executive Office. There has been established A Damien Inter-Agency Working Group, where Damien is an acronym of "Detecting and Mitigating the Impact of Earth-Bound Near-Earth Objects." In government, it is important to have an awesome acronym.

The National Near-Earth Object Preparedness Strategy and Action Plan is a document that address the topic of Planetary Defense over a ten year span. It is used to co-ordinate efforts among government agencies. The plan has five major goals. The first is to focus on NEO detection, tracking, and characterization. The second goal is to improve models and prediction, and to address Information integration for decision making. The third goal is to develop technologies for NEO deflection and disruption. NASA is the lead for this effort. The fourth goal is to increase International Cooperation on NEO Preparedness. This will involve International support and education. The fifth goal is to "strengthen and routinely exercise NEO Impact Emergency Procedures and Action Protocols."

NASA has a Planetary Defense Officer. This position will probably

move to Space Command. NASA's Planetary Defense Coordination Office is under NASA's Planetary Science Division. It is tasked with tracking and cataloging NEO's larger than 30 meters. That task may remain with NASA. NASA also has a Orbital Debris Program Office, that works closely with the Air Force.

In October of 2017, NASA had an opportunity to test the international asteroid warning network. Asteroid 2012 TC4 went across Antarctica at around 26,000 feet altitude. The size of the asteroid was estimated to be around 30 meters. The event was broadcast across the globe, and numerous telescopes looked where the coordinates told them, and sent their data findings.

It was estimated that we are at least 10 years away from having a viable response to a hazard that a rock such as this could pose. At the moment, we can only document it, and wish real hard.

Glossary of terms and acronyms

AATIP - Advanced Aerospace Threat Identification Program.

ABM – anti-ballistic missile.

ABMA – Army Ballistic Missile Agency, Redstone Arsenal, Huntsville, Alabama.

AFB – Air Force base.

AFSPC – Air Force Space Command

AIC – (U. S.) Air Intelligence Command.

Albedo – measure of reflectivity.

AMC – Air Force Material Command

AMU – (U. S. Air Force) astronaut maneuvering unit.

Antipodal - the diametrically opposite point on the Earth also known as an antipode.

APRO - Aerial Phenomena Research Organization.

ARPA – (U. S.) Advanced Research Projects Agency.

ARSPACE - Army Space Command. ASAT,

ASAT – anti-satellite weapon.

ASCII – American Standard Code for Information Interchange. 8-bit.

ASPO - Army Space Program Office.

Astropolitics – a spinoff of terrestrial politics.

ATIC - Air Technical Intelligence Center.

BEO – beyond Earth orbit.

BMEWS – Ballistic Missile Early Warning System.

BMI – Battelle Memorial Institute.

CETI - Communication with Extraterrestrial Intelligence.

CSpOC – Combined Space Operations Center.

C-stoff – German rocket fuel. WW-II vintage.

DARPA – Defense Advanced Research Projects Agency.

DCI – Director of Central Intelligence.

DIA - Defense Intelligence Agency.

DoD – (U.S.) Department of Defense.

Elevon – aircraft control surface combining pitch and roll control.

ESA – European Space Agency.

ETI – extra-terrestrial intelligence.

FTD – Foreign Technology Division of Wright-Patterson AFB.

GPS – Global Positioning System. Satellite based navigation.

HELSTF - High Energy Laser Systems Test Facility.

Hypergolic – a fuel and an oxidizer that ignite upon contact.

Hypersonic – Mach 5 or above

IAA - International Academy of Astronautics.

ICBM – Intercontinental Ballistic Missile.

IPU - Interplanetary Phenomenon Unit, US Army.

JFCC Space - Joint Functional Space Component Command.

Karman line – 100 km, the "official" beginning of space.

Lbf – pounds, force.

LEO – low Earth orbit.

LOP-G – Lunar Orbital Platform – Gateway.

Mach number – speed of sound at the ambient temperature and pressure.

METI – Messaging to Extraterrestrial Intelligence.

MIG – Soviet and Russian aircraft company.

MILSATCOM - Military Satellite Communications Directorate

Milstar - Military Strategic and Tactical Relay- constellation of comsats.

MISS – man in space soonest.

MOL- (USAF) – Manned Orbiting Lab.

NACA – National Advisory Committee for Aeronautics.

NARA – National Archives and Records Administration.

NASA – National Aeronautics and Space Administration.

NASIC – National Air & Space Intelligence Center.

NASP – National Aero-Space Plane.

NEO – Near Earth object.

NESS - Near Earth Space Surveillance.

NICAP - National Investigations Committee On Aerial Phenomena.

NORAD – North American Aerospace Defense Command, Cheyenne Mountain, Colorado. Joint U. S. /Canada.

NRO – (U.S.) National Reconnaissance Office.

NSC – National Security Council;

NSSCC - National Space Surveillance Control Center

NTIS – National Technical Information Service (www.ntis.gov).

OTV – orbital test vehicle.

PDP = post detection policy

PHA – potentially hazardous asteroid.

Project Mogul – top secret project by USAF to monitor Soviet Nuclear tests, 1947-49.

RAAF – Roswell Army Air Field

Redstone Arsenal – Army R&D facility in Huntsville, AL. Later became NASA MSFC.

RoBo – rocket bomber.

Satcon – Satellite Control Battalion.

SETI – Search for Extra-Terrestrial Intelligence.

SI – System International – the metric system.

SigInt – signals intelligence.

SMD – Space & Missile Defense.

SMDAC - Space and Missile Defense Acquisition Center

SMDBL - Space and Missile Defense Battle Lab

SMDC– (U. S. Army) Space and Missile Defense Command.
SMDTC – U. S. Army Space and Missile Defense Technical Center.

Ssa -space situational awareness.

SSTO – single stage to orbit.

T-Stoff – high test peroxide, used in German rockets.

UAO – Unidentified aerial object.

UAP – unidentified aerial platform, unidentified aerial phenomena

UDMH - Unsymmetrical dimethylhydrazine, a rocket fuel.

UFO – unidentified flying object.
UFOB – (USAF), unidentified flying object

ULA – United Launch Alliance

USAF – United States Air Force.
USASMDC - U.S. Army Space and Missile Defense Command

VAFB – Vandenberg Air Force Base – launch site for polar orbits.
WSMR – White Sands Missile Range, New Mexico.

WTR – U.S. Western Test Range, Vandenburg AFB in California

launch site.

XOV – experimental orbital vehicle, part of the Blackstar project.

X-plane – experimental aircraft.

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